Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

1.9
2524W

United States Department of Agriculture
Bureau of Biological Survey

Wildlife Research and Management Leaflet BS-104

Washington, D. C. * February 1938

THE STATUS OF WILDLIFE RESEARCH: 1937

By W. L. McAtee, Technical Adviser and Research Specialist
Office of the Chief

Contents

	Page		Page
Research by the Bureau of Biological Survey	2	Research by colleges and universities	13
Research by the Biological Survey and cooperators	4	Research by museums	17
Federal Bureaus	4	Research by miscellaneous establishments	18
Land-grant Colleges	6	Canadian wildlife research	20
Other State institutions	7	Cost of wildlife research	20
Research by Federal bureaus other than the Biological Survey	8	Number of projects	21
Research by State conservation departments	10	Number and synopsis of subjects	22
		Conclusion	30

The layman seems often to think of research as a mysterious proceeding with which he personally has nothing to do, and possibly also as a "highbrow" activity of little or no practical application. These traditional conceptions to some extent are passing, because we are now literally surrounded by the results of research in the fields of electricity, aviation, radio, and other utilities of modern life. Still the term research by itself seems rather forbidding, and with modifiers such as "scientific" or "pure," entirely so.

Nevertheless research, meaning careful or diligent search, is something every man must do to assure success of his undertakings. He must search diligently if he is to achieve satisfaction in the choice of a home, or of a doctor, or a lawyer. He must himself learn about the laws that affect his business, he must use discrimination as to the quality of materials he may handle, investigate the dependability of sources of supply, ascertain the financial responsibility of those with whom he deals, and so on. All of this is research, and every man does it.

Research may well be defined as fact-finding. The dictionary gives a good many definitions of the word "fact", but to the "man-in-the-street" and to the scientist as well, it means dependable information. Perhaps the

scientist would prefer to say verified information, and it is in the process of verification, if anywhere, that his research differs from that of the layman. Scientific fact-finding, at its best, is guided by the most careful methods that can be used, and verification often takes the form of repeating observations over and over until an average result is attained that is far more dependable than any one, or any few, instances. This is something that may take considerable time, especially in wildlife research, where opportunities to make observations on a particular phase of a creature's life history may come only at yearly intervals.

The necessity of repeating observations and the length of time this often requires may make the layman think that scientific research is puttering, but then is the time to recall that "art is long and time is fleeting." Particularly in this era of phenomenal extension of wildlife management should it be borne in mind that sound structures are not built in a hurry. While we must go ahead the best we can with the facts available, we should also seek earnestly to increase both our store of information and its reliability. This requires not only ample time, but also first-class facilities for investigators, and last, but not least, the security of employment and adequate remuneration that alone can give the peace of mind essential to concentration by the worker on his job. It is believed that these truths about research are being increasingly recognized by those in charge of wildlife administration who so greatly need the aid of more and more efficient fact-finding investigations.

Further comment suggested by the present inquiry is that programs tend to be too extensive. Considering the time-consuming character of research, it is evident in some cases that programs are outlined as well under way that cannot be completed in the lifetime of all of the workers available for them. Another fault is classing as research, activities that are of demonstrational or even administrative nature. Calling a thing experiment or research does not make it so. There should be little difficulty, however, in deciding what is research and what is not; it requires only distinguishing between what is primarily fact-finding and what is predominantly fact-using.

This review is restricted to recently completed, presently active, and imminently pending research on birds and mammals in nature and to studies of their environment and factors thereof that have a bearing on management in the wild.

Where to begin inventory of the abundant and diverse material is a problem. By long association, if for no other reason, the writer is inclined to think first of the research activities of the Biological Survey, and analysis of the reports assembled as a basis for this account shows that the Survey leads in the number of going research projects, both of its own and of those carried on in collaboration, and that the Bureau is also the most sought cooperator for joint undertakings in this field.

RESEARCH BY THE BUREAU OF BIOLOGICAL SURVEY

It is not the purpose of this article to recall the history of wildlife research but to cite only the more important definite projects in illustration of the trends of the period. In its oldest branch of wildlife research--study of food habits--newer investigations of the Biological Survey include those on the food of the mourning dove and coot; continued from previous years are those

of the bobcat, red fox, armadillo, white-necked raven, and raptorial birds; and recently reported upon are those of the coyote, fish-eating birds, and the scaled quail. In connection with the laboratory work on food habits, studies to facilitate identification of hair and seeds have been made.

Field investigations of injurious species are headed by important studies of crow-waterfowl relationships in nesting areas. In 1934 and 1935 the work was carried on in Saskatchewan and Alberta and revealed destruction by crows of 31 percent of the 572 duck nests studied. In 1936 the investigation was transferred to the Lower Souris Migratory Waterfowl Refuge in North Dakota, where crows were implicated in only 1.7 percent of the nest destruction and skunks in 30.6 percent. In 1937 studies continued at the same place showed foxes to be the chief predators. The diversity of these findings clearly indicates the fallacy of generalizing about predation and proves the necessity of local and timely investigations as a basis for rational management procedure.

The accusation of destruction of quail eggs by armadillos in Texas, which has cost the lives of so many of these highly insectivorous mammals, was thoroughly studied and proved to be largely unfounded. Baltimore orioles were reported destructive to cherries, grapes, and other fruits in New York, and investigation showed the need of control. Recent research led to the publication of leaflets entitled "Suggestions for Combating Starling Roosts", "Protecting Crops from Damage by Horned Larks in California", and "Excluding Birds from Reservoirs and Fishponds", all of which emphasize the use of preventive methods involving no destruction of birds. Studies for the improvement of control procedure reported upon this year by the Control Methods Research Laboratory at Denver, Colo., relate to the meadow mouse, pocket gopher, and coyote, and to the development of selective poisons.

In this report on wildlife research, it will be necessary to mention, in addition to work with animals themselves, various studies of environmental factors, better understanding of which is essential to satisfactory management. Among such investigations now being carried on by the Biological Survey are experimental propagation and transplanting, and control of competitors, of food and cover plants important to migratory waterfowl; this is a newly organized project that is being carried on in the vicinity of Washington, D. C., in the Mississippi Delta, La., and in the Bear River Marshes, Utah. Study of the depletion of eelgrass on the Atlantic coast and its effects on waterfowl is being continued, as well as experiments in transplanting uninfected strains from the Pacific to the Atlantic coast. Reports on wild-fowl food plants await publication, a check-list of marsh and aquatic plants has been issued, and the results of years of study of fruits attractive to birds and of plants valuable for wildlife utilization as cover, browse, herbage, mast, fruit, and seed have recently been published.

Field study and experimental work on the effect upon birds of arsenical poisons used in insect control has been inaugurated to throw light on a problem that has so far been the subject of mostly uninformed comment. The relation of grazing to upland game is being studied on the Wichita Mountains Wildlife Refuge, Okla., and to waterfowl on the Bear River Migratory Waterfowl Refuge, Utah. At the latter reservation comparative tests are being made of methods of taking censuses of waterfowl, and research is in progress also on crippling losses, the nesting adaptability of wild fowl, and the sex

ratio in wild ducks and muskrats. The life history of the muskrat, its season of primeness, and management methods have been studied locally in Maryland and elsewhere. This investigation and another on the sexual cycle, gestation period, and embryology of the coyote have already been reported on in manuscript.

Field investigations (other than cooperative) in diseases of wildlife relate to the extent of lead poisoning of waterfowl and to the search for methods of controlling outbreaks of botulism among these birds.

The waterfowl are also the subject of range and migration studies, of observations on prospective refuges on their breeding grounds and in their winter homes, as well as of annual numerical surveys, so that adequate information will be available to guide the drafting of the Federal hunting regulations; banding of birds in general is being continued as part of the migration and distribution studies.

Along the lines of its time-honored faunal investigations, the Biological Survey has recently published on the mammals and life zones of Oregon, the resulting 400-page book being the 55th in the famed North American Fauna series. Surveys aimed toward similar results for Arizona, Florida, Georgia, and Wisconsin are in progress. In a study of the biology of the Aleutian Chain, special attention has been given to the sea-bird colonies and their depredators, especially the Arctic fox. Among taxonomic investigations, revision of the clapper rails has just been published, one on the spermophiles is in press, and others on tree squirrels, pumas, and wolves are in preparation.

RESEARCH BY THE BIOLOGICAL SURVEY AND COOPERATORS

Federal Bureaus

The research projects thus far listed include the most important, at least, of those in which the Biological Survey is independently engaged. Its cooperative undertakings are even more diverse and widespread. It seems natural first to review cooperative arrangements with other Federal bureaus. For convenience those in the Department of Agriculture will be taken up alphabetically, except that relating to the Forest Service, the longer account of which will be briefly deferred.

Bureau of Agricultural Economics.-- A very important undertaking in cooperation with the Bureau of Agricultural Economics, now in its second year, is a nation-wide study of the possibilities of wildlife as a supplementary farm enterprise. Tentative conclusions as drawn to date are as follows:

"The study thus far indicates that wildlife, to be perpetuated, must be produced by natural reproduction on farm lands as well as on land publicly owned. State or Federal lands alone cannot supply sufficient wildlife or adequate facilities for its use and enjoyment by the public. Artificial propagation and restocking have proved to be unduly expensive as a direct means of providing hunting; and uncontrolled public shooting, especially on private farmland, has proved destructive both to wildlife and to farm property. Due respect for property rights is fundamental to success in encouraging private landowners to produce wildlife. The monetary consideration, particularly on lands of high value that are intensively used for agriculture, is of minor importance, and under present conditions it is not offering an adequate incentive for wildlife production on farms."

Bureau of Animal Industry.-- At the request of the Bureau of Animal Industry a study was made in Florida of the susceptibility of deer to tick fever and their importance as a reservoir of the disease, which is transmitted from animal to animal. The deer were found clearly to be involved, and plans were made by the Florida State Livestock Sanitary Board for slaughter of a large number of them. Protest by sportsmen of the State, however, brought about indefinite postponement of this project.

Bureau of Entomology and Plant Quarantine.-- In collaboration with the Bureau of Entomology and Plant Quarantine, and to some extent with other Federal and State agencies, the Biological Survey is thoroughly investigating the effects of mosquito-control operations on wildlife. Search is being made for control methods that will not be deleterious. In connection with this project, investigations are made of proposed drainage activities, of which those coming under the Works Progress Administration must have Biological Survey approval before being adopted.

Farm Security Administration.-- The Biological Survey has assisted the Farm Security (formerly Resettlement) Administration by inspections and advice in connection with studies in food and cover manipulation for quail (Maryland), nursery tests of food-producing trees and shrubs (Maryland), and farm-game development (New York and New England), and the Administration has helped the Survey in studies of the ruffed grouse, woodcock, and deer (Maine).

The Soil Conservation Service desires specific information on the local utilization by wildlife of food supplies provided by the natural and planted vegetation on erosion-control projects, and collects small numbers of stomachs, analysis of the contents of which, made in the laboratory of the Biological Survey, will give the desired information. On its own account the Soil Conservation Service has made comparative studies of feed-patch seed mixtures, and the men in its Wildlife Division make censuses of game and collect information on the value to wildlife in various ways of the vegetative cover with which they constantly work.

Forest Service.-- Required to deal with wildlife on national forests for many years, the Forest Service has found it necessary to undertake certain studies for the purpose of improving management. In earlier years these were independent and some of them still are, but in more recent times numbers of these research projects have been conducted in cooperation with the Biological Survey, and by agreement between the two Bureaus all of them eventually will be so conducted. Projects that have so far come to the compiler's attention are here noted in geographic sequence, beginning with the West.

In Washington State, management studies of the Olympic elk have been necessitated, and surveys of winter range on the Chelan National Forest have been attempted. In California national forests, studies of deer range and of the comparative palatability of plants browsed by mule deer have received much attention. There is a definite cooperative project in this State also on the relation of wildlife to the regeneration of pine forests and to the production of range forage. In Region I, with headquarters at Missoula, Mont., partially reported food-habit studies of deer, elk, and other big game, both by stomach analyses and by field browse palatability ratings, are being carried on in 17 national forests. In Utah, cooperative research on summer and winter deer range is in progress on the Fish Lake National Forest. Definite cooperation with the Lake States Forest Experiment Station at St. Paul, Minn., involves regional investigation of rabbits and rodents in relation to forest planting,

and food and management of the white-tailed deer and beaver. Similar work on the deer on the Clark National Forest in Missouri has recently been reported upon by the Forest Service, and a cooperative agreement with the Biological Survey provides for life history and management studies of the wild turkey in 8 national forests in the Ozark region. A mimeographed progress report entitled "The Wild Turkey on the Missouri Ozark Range" has been issued.

In New Hampshire there is a winter deer range study on the White Mountain National Forest, and in Pennsylvania on the Allegheny Forest there are a number of pieces of research covering weights, measurements, and winter range of deer, management of beaver, census methods for wildlife, and egg and brood survival of ruffed grouse. The grouse is also an object of research on the Monongahela National Forest in adjoining West Virginia. Cooperative investigations of the food habits of the ruffed grouse, wild turkey, foxes, and bear are being made on the George Washington National Forest in Virginia. A study of the food of the white-tailed deer carried on for some years on the Pisgah National Forest, North Carolina, has been aided by analysis of stomach contents by the Biological Survey. General game food studies are being made on national forests in Florida and a definite cooperative undertaking on the Harrison Experimental Forest in Mississippi deals with birds and rodents in relation to tree reproduction, particularly of the longleaf pine. Bumper crops of seeds attract many birds and other seed consumers, but where local seed production is low and wildlife populations normal, plantings are fairly safe.

Public Health Service.-- A Federal agency outside the Department of Agriculture with which the Biological Survey cooperates is the Public Health Service, for which animals are collected for investigation as carriers of human diseases.

Land-grant Colleges

Under the designation Cooperative Research in Wildlife Management, falls a most important group of cooperative research undertakings of the Biological Survey. Made possible in 1935 by pledge of funds from the American Wildlife Institute and by Congressional appropriation, nine of the projects were organized in cooperation with land-grant colleges and State conservation departments, and begun early in 1936. Efforts were made to appoint the best available leaders, and the average fitness of those selected is high. Besides research, each project includes education and demonstration in wildlife management. In each case a major research problem has been assigned and in addition one or more minors.

Alabama.-- Taking up the units by States in alphabetical order, in Alabama the principal project is a life-history and management investigation of the mourning dove. The minors include a study of bobwhite, as a local supplement to the Cooperative Quail Investigation of 1924-29, which was carried on in adjoining States; an ecological research on lumbering in relation to the white-tailed deer; studies of the food of foxes; and investigations of wild turkeys as affected by the spring shooting of gobblers.

In Connecticut the leading activity is a thorough study of the cottontail and its management. Here also tests are being made to learn what strains of crop plants are best adapted for use in feed patches. The possibilities of analyzing cover and food vegetational types and of correlating with them the occurrence and abundance of wildlife are being explored. Statistical

studies have been completed for the purpose of devising a standard method of estimating and predicting the populations of game species as an aid to administration.

The Iowa unit has completed a report on "The Ecology and Management of the Blue-winged Teal" and has undertaken similar work on the coot, mourning dove, cottontail, muskrat, raccoon, and two species of skunks. Studies of quail and pheasants, combined with the farmer-sportsman relationships involved in the harvesting of these birds, also are proceeding. Other items in the program concern the parasites and diseases of wildlife, especially common game species, and distribution and ecology of plants in the waterfowl breeding areas of Iowa.

Maine.-- Appropriate to the Maine situation is an investigation of logging and silvicultural operations in relation to the welfare and distribution of ruffed grouse and deer. Other studies have been instituted to learn what is practicable in woodcock management, to throw light on the relations of fish-eating birds to fish parasites, and to determine the cause of heavy losses of moose late in winter and in spring.

In Ohio demonstrational and educational activities have been prominent, but research is in progress on life histories of squirrels, deer, and ruffed grouse, and on diseases of the introduced pheasant and partridge.

Oregon.-- A general small-game investigation was undertaken in Oregon to reveal limiting factors and the possibilities of modifying them; studies of the life history and management of the antelope and of the birth rate and sex ratio of deer also are under way.

The Texas unit has as its major project a survey of the wildlife resources of Walker County, but has carried on research on the life history of gray and fox squirrels and the bobwhite, and of Attwater's prairie chicken, with a special view to measures necessary to preserve this threatened subspecies. The Texas legislature has responded by providing a 5-year close season on the bird.

In Utah, life history and management of the Rocky Mountain mule deer is the principal study, but special attention is being given also to the beaver in relation to stream flow and the welfare of game fishes, to the Columbian sharp-tailed grouse and the sage grouse, and to factors governing the distribution of waterfowl food plants. It has been found that livestock competition is the main obstacle to the reestablishment of the sage grouse.

Virginia.-- Forest-game studies predominate in Virginia and relate principally to the wild turkey, ruffed grouse, and white-tailed deer. Other investigations pertain to the food habits of foxes and to factors controlling survival of the bobwhite.

Other State Institutions

Minnesota.--In addition to collaborating in this unified series of research projects, the Biological Survey cooperates with other States and State institutions individually. The most important instance is the Minnesota Disease

Investigation with the State University, upon which several people are employed. The research concerning animals in the wild relates to the diseases and parasites of small birds and mammals, of moose and deer, and of cyclic species, particularly the snowshoe hare and the ruffed grouse; and to development of a nontoxic alloy for use in the manufacture of shot for duck hunting, which if substituted for that now employed would eventually do away with the menace to waterfowl of lead poisoning. A promising lead magnesium alloy has been found, but the investigation will be continued. It is believed that the disease responsible for the periodic die-off of the snowshoe hares has been identified. Its effect is to reduce blood sugar to a fatal level; from symptoms it has been named shock disease.

In Nebraska, study of duck sickness on the alkaline lakes of the Sandhill Section by representatives of the Biological Survey has been facilitated through collection of ailing birds by the State Game Commission.

Oklahoma.-- Life-history and management investigations of the lesser prairie chicken and bobwhite in cooperation with the State Game and Fish Commission of Oklahoma were briefly reported on in 1936.

New Hampshire.-- A State forest is the site of investigations in New Hampshire of cover manipulation as affecting the ruffed grouse and other wildlife. These are intended to develop methods that can be applied where desired in the ever-increasing area reverting to woodland in New England.

Bureau cooperation.-- The Biological Survey has always cooperated with the States in making the food analyses so readily done in its laboratories but so difficult where similar equipment and collections are not available. Among the more extensive recent investigations of this character have been examinations of material illustrating food habits of the ruffed grouse and foxes, for the New York Conservation Department; of the American merganser and otter, for the Michigan Department of Conservation; of a general collection of predators, for the Kellogg Bird Sanctuary, now attached to the State College of Michigan; and of hawks killed for bounty, for the Pennsylvania Board of Game Commissioners.

RESEARCH BY FEDERAL BUREAUS OTHER THAN THE BIOLOGICAL SURVEY

Department of Agriculture

Including certain organizations previously mentioned in connection with cooperative work are some bureaus that carry on also independent research bearing upon wildlife.

Bureau of Animal Industry.-- Of those in the Department of Agriculture, the Bureau of Animal Industry indexes the world literature, and has assembled an outstanding collection, of parasites, which it studies for one purpose, among others, of learning about transfers of parasites from wild to domestic animals or the reverse. Its taxonomic investigations have dealt with groups parasitic in ruminants and in such important game birds as grouse and quail. In this field of work the Bureau of Animal Industry deals largely with internal worm parasites.

The Bureau of Entomology and Plant Quarantine.-- Investigates chiefly external arthropod (insect and allied) parasites. Research has laid the ground work for control of these organisms whenever it shall be found necessary. The destruction of quail in the egg by fire ants is being studied in an attempt

to develop a point of attack in reducing it. In connection with the cooperative work on mosquito control previously referred to, the Bureau of Entomology has aided in the development of a pyrethrum larvicide that is harmless to wildlife and plants. Investigations have been made in a few cases of destruction by insects of plants valuable as food for wildlife, with a view to controlling the damage.

The Farm Security Administration, though concerned mostly with the development of the projects with which it has been associated, has found it necessary to solve problems basic to such development, so it has done, and is doing, considerable research. Aside from that already mentioned as cooperation between Federal bureaus, the Farm Security Administration in collaboration with the New York State Conservation Department is investigating the effects of slashings in relation to the food and cover requirements of ruffed grouse and of deer. Study of the food and ranging habits of quail in relation to restocking has been made in Delaware, Maryland, and South Carolina; and of the wild turkey in Kentucky. Search for effective methods of reestablishing food and cover plants on areas where they have been destroyed by fire or other agents also has been prosecuted in the Southeast. The Farm Security Administration's Region 2 (lake States) has been the scene of more wildlife research than any of the others, as in planning and executing development of projects in that area it was confronted with the necessity of obtaining information on the numbers, population trends, and environmental needs of the more important species. Among those being studied are the woodland caribou, moose, snowshoe hare, sandhill crane, prairie chicken, and sharp-tailed grouse. Numerous special investigations of more limited scope, most of them relating to phases of management, also are in progress.

Other Departments

Leaving now for the first time the circle of Department of Agriculture bureaus and their cooperators, the wildlife programs of a few other Federal organizations may be noted.

The National Park Service, whose work is almost exclusively conservation in nature, also participates in wildlife research. Among important projects at this time are a study of bighorn sickness and reasons for the decline in the population of these animals in Glacier National Park, Mont.; food habits of the coyote and the ecological status of the species in natural areas, Calif.; range studies as bearing on wildlife problems, with special reference to elk and bighorn, Grand Canyon, Rocky Mountain, and Yellowstone National Parks; nesting studies of the trumpeter swan, Yellowstone National Park; the utility of artificial lakes to wildlife, Virginia; and effects on wildlife of spraying forests with arsenicals, New York.

The Public Health Service studies native animals to reveal their importance as reservoirs of diseases transmissible to man. At present this work relates to various mammals in the South, particularly rodents, to determine the prevalence of typhus; to rodents in the West, with reference to plague; and to rodents and birds generally, as part of the investigation of tularemia.

The Tennessee Valley Authority has embarked upon comprehensive research on the physical, chemical, and biological aspects of impounded waters in relation to their management and upon factors affecting the biotic potential and interrelations of numerous animals as a guide to game management. Among details of these studies may be mentioned the testing of scattered game-food plantings, to determine their value and practicability for use on a large scale; study of the effects of malaria control measures on animal and plant life of the project area; and investigation of the food of quail in northern Alabama. More than 40 manuscript reports have been made on local biological studies.

RESEARCH BY STATE CONSERVATION DEPARTMENTS

Federal agencies, it is evident, are doing a great deal, and a great variety, of research bearing both directly and indirectly upon wildlife. What of the States? Nine of them have already been mentioned as cooperating in research with the Biological Survey. Some of these had previously supported research and some are still carrying on scientific investigations independently of the cooperative arrangement.

All of the State conservation departments were addressed and six (Arizona, Colorado, New Mexico, North Carolina, South Carolina, and Rhode Island) reply that they have no present wildlife research; 15 in addition to those in the Federal-State cooperative chain report research to varying extents; and 18, not heard from, certainly include several that now are supporting, or recently have supported, some research. Certainly more than half the States are contributing independently or cooperatively to the advancement of wildlife research, which only can give an adequate basis of reliable information for the guidance of their administrative, regulatory, and management activities.

Outlines of greatly varying adequacy of the wildlife-research activities of States, aside from the Federal-State cooperative program, follow.

Illinois.--The State Natural History Survey Division has the responsibility of developing the wildlife-research program. Projects of the Section of Game Management include life-history and management studies of the bobwhite, the pheasant, and particularly of prairie chickens in an isolated colony in the south-central part of the State, where there has been no serious loss of range in recent years. The research program involves also study of the behavior of quail populations in a good hunting area; work on the food habits of bobwhite and pheasant, and a study of the correlation of bird and insect populations in a variety of types of environment; investigation of the parasites and diseases of a number of species, including fur animals, waterfowl, prairie chicken, ring-necked pheasant, and bobwhite; tests of the comparative value of cultivated grains for use in feed patches in various sections of the State and on different soils; and analysis of reports of trappers to determine areas of abundance or scarcity, and changes in number of fur animals as well as the monetary return from the sales of skins.

Indiana.--Studies are being made on two game-management areas to determine the minimum improvement necessary to maintain a desirable abundance of upland game on the average farm.

Maine.--An investigation apparently independent of the Federal cooperative program is an evaluation, by graduate students of the State University, of all known ruffed grouse census methods to learn what is best suited to Maine conditions. A prospective investigation is of the life history of the raccoon, with special attention to limiting factors and the possibility of modifying them.

Maryland.--In cooperation with the Farm Security Administration the State Conservation Department supported research on the winter foods of the bobwhite and the cottontail as a guide to environmental improvement by the use of both feed patches and more permanent plantings.

Michigan.--The Game Division of the Department of Conservation, with a staff of 15 or more investigators, is making progress on an extensive research program. In a State where farmer-sportsman relationships have already received much attention, the Game Division is making a special point of studying farm-game management and the effects thereon of cooperative hunting clubs. Methods of regulating hunting pressure on small game and the effects of controlled hunting also are being investigated. Life history studies of the cottontail, fox squirrel, skunk, and beaver are in progress, but for a variety of other forms, attention to specific problems or ecological requirements is preferred. For instance, with the moose, the overpopulation on Isle Royale and methods of relieving it are the principal objectives of research; with deer, accurate inventory of the population and studies of food and cover management lead; such specialized investigations have been begun also in the case of the ruffed grouse, prairie chicken, sharp-tailed grouse, and waterfowl. Ecological studies of predators to determine populations, their mobility, and food habits are in progress. Disease investigations cover the wildlife field in general, with special reference to fluctuations in populations (including studies of cycles on a long-time basis), and to life histories of important parasites. The Game Division plans a Wildlife Experiment Station on land provided by the Farm Security Administration, where many of its researches will be facilitated.

Minnesota.--In this State wildlife research is not only bilateral between the Department of Conservation and the State University, but trilateral (Biological Survey added), or even quadrilateral (including also the Forest Service). These 3- and 4-party cooperative researches have already been discussed. Those between strictly State agencies include (a) completed studies, distribution of fur and game species, and food habits of the pheasant; (b) current research, pheasant grit requirements, pheasant repellents, deer population and mobility, and management of beavers and other fur animals; and (c) a contemplated study of the distribution, habits, and economic relations of the gray fox.

Mississippi.--Survey of the distribution, abundance, and economic importance of wildlife, and of food and cover conditions.

Missouri.--At the request, and with the support, of the Conservation Commission, the State University has undertaken a 5-year research program to determine the adaptability of the chukar partridge to conditions in the State. Arrangements were under way at the close of the year for the establishment of a three-party research station at Columbia, involving the University, the Commission, and the Biological Survey.

Nebraska.--During 1936-37 the Game Commission in cooperation with the State Agricultural College has been carrying on an investigation of diseases of the prairie chicken and the sharp-tailed grouse. An attempt is being made to test the claim that bobwhites deteriorate through inbreeding. The method--introducing new birds into established coveys in an attempt to increase the population--hardly seems to meet the demands of rigorous experiment.

New Jersey.--Studies under the Board of Fish and Game Commissioners in this State are restricted to evaluation of management practices, such as the

best composition of feed-patch mixtures, the adaptability of various species of Lespedeza to game feeding, and the trends of wildlife populations on game-management areas and public shooting grounds.

New York.--The ruffed grouse investigation, now in its seventh year, is being continued; it has resulted in the amassing of vast data that are being carefully analyzed; efforts at artificial propagation have been rewarded by the rearing to maturity of 1,200 birds. Research has been directed toward the development of more economical methods of artificial propagation and distribution of ring-necked pheasants and toward the significance and alleviation of winter starvation in this species. The efficiency of stocking procedure with both the quail and the mallard has been tested. Attempt is being made to develop a black duck-Flanders duck hybrid that will combine the wildness of the former with the fecundity of the latter. A comprehensive study of the white-tailed deer, now six years in length, gives special attention to limiting factors and to deer populations as affected by environment and by hunting. For six years, the pathology of wildlife and of game species reared in captivity has been a subject of research.

Ohio.--Ohio is one of the States in the Federal-State cooperative chain that has long carried on wildlife research independently. The personnel doing work on birds and mammals having been absorbed by the cooperative unit, research by the State Conservation Division seems now largely restricted to fish problems. Investigations of the other groups reported upon in recent years include surveys of the wildlife resources of Ohio, life history studies of squirrels, the groundhog, and the cottontail, and food habits of upland game birds (bobwhite, Hungarian partridge, pheasant).

Pennsylvania.--The Board of Game Commissioners has commendably provided for the banding of all game birds (except wild turkeys) that it releases in restocking operations and also for the tagging of a limited number of wild-trapped birds and mammals, including deer and bear. Study is being made of wild turkeys on natural range, with the particular object of facilitating restocking. Research of a physiological nature on breeding and nutrition of deer is another going project. Plans call for a detailed analysis of the stomach contents of all hawks and owls submitted with claims for bounty, and study of the physiology of game species in relation to climatic conditions.

Utah.--In addition to research mentioned in the account of Federal-State cooperative units, the Utah Department of Fish and Game is gathering information on ranging habits, food preferences, sex ratios, and limiting factors, including diseases and parasites of the elk; on crop damage by pheasants; and on the status of bird rookeries of Great Salt Lake.

Vermont.--The Fish and Game Service of the State, in cooperation with the National Park Service, has supported an environmental study of deer in Windham County, with special attention to range selection and crop damage by the animals and the effect of hunting on their population. Inquiry has been made also into the status of the pheasant as a basis for the stocking policy; a statistical investigation of fur production has recently been completed; and the State ornithologist has been commissioned to report on the condition of ruffed grouse and on the bird populations of certain refuges.

West Virginia.--The recent establishment of a Division of Game Management under the Conservation Commission assures future prosecution of research, although up to that time little had been attempted. Studies under way include determination of the breeding season and fecundity and environmental limitations of the white-tailed deer, breeding periods and migrations of the gray squirrel, relations of beaver to fishing streams, and the effects of refuges on game populations.

Wisconsin.--The Conservation Department bands all game birds released on licensed shooting preserves and carries on a grouse-banding project in cooperation with the State University. Experiments in stocking a number of previously untested species of game birds is part of the work of the State Game and Fur Farm.

Wyoming.--The Game and Fish Administrative Law, passed by the State Legislature in February 1937, for the first time authorized the Game and Fish Commission to undertake research. The program has only begun, but includes two items pertinent to this summary: Study and selection of the best site for refuge areas for the sage grouse; and a range study of elk in cooperation with the Forest Service in the Washakie National Forest, as a basis for management.

RESEARCH BY COLLEGES AND UNIVERSITIES

Land-grant colleges were involved in each of the nine research units of the Federal-State cooperative chain, and universities in other States have been mentioned as cooperating with State conservation departments in wildlife research. Numerous institutions, no doubt, are participating in wildlife work, particularly since the recent great arousal of interest in game management. The scope of this program is by no means all known, but such information as is available is here outlined according to the names of schools in alphabetic order, and of the State, where it is part of the authorized designation.

Arizona, University of (Tucson).--Well known is experimental establishment at the University of Arizona of palatability ratings of native food plants of the Rocky Mountain mule deer and the Arizona white-tailed deer; the physiology, especially the glandular activities, of these species also is being studied. Ecological investigation of factors influencing the distribution of the whitetail is another going project.

Bowdoin College (Brunswick, Me.).--Work on the life history of the ruffed grouse is being continued, and similar research on the eider duck, black guillemot, and black-backed gull is well under way. Research on the herring gull thus far has primarily concerned its migrations, diseases, and parasites.

California, College of Agriculture (Davis).--Studies the biology of valley quail on both farm and range lands, with special reference to possible limiting factors peculiar to these environments, as the effects of cultivation and other farm practices, and of competition from rodents and from livestock. In cooperation with the Forest Service, criteria for estimating the age of

California deer are being investigated; and with that of the State Board of Public Health and the Hooper Foundation for Medical Research, the biology of rodents and fleas in relation to plague. Reports have recently been made on the behavior of the muskrat as an alien both in California and in Europe, its economic status, and the success of control measures; and on birds as depredators upon almonds.

Carleton College (Northfield, Minn.).--Life histories and intraspecific relationships of Arctic terns and Atlantic puffins on Machias Seal Island, Maine.

Cornell University (Ithaca, N. Y.).--Research upon native birds and mammals is engaged in by several departments at Cornell to such an extent that in all likelihood this resume is defective. Studies of the mating cycle of the ruffed grouse as bearing upon artificial propagation, carried on for some time, are being supplemented by similar work on other birds, particularly the canvasback and other diving ducks. Life histories published include those of the double-crested cormorant, woodcock, horned lark, and tree sparrow; one completed but not published concerns the horned owl; and those in progress relate to the black duck, turkey buzzard, screech owl, ivory-billed woodpecker, phoebe, blue jay, redstart, robin, wood thrush, and English sparrow. Investigations of the juvenal plumages of Fringillidae, of birds of Oklahoma and Texas, and of the taxonomy of red-tailed hawks and blue jays also are under way. The well-known research on methods of recording bird song also must not be forgotten.

The work on mammals at Cornell has included valuable nutritional studies, one of which, "Food Preferences and Requirements of the White-tailed Deer in New York State", has been published. A long series of papers on the food habits and economic relations of mammals produced in Cornell form the backbone of our body of information on these subjects, and further work along this line is being done, notably a study of the food of the bobcat in Vermont (in collaboration with the Fish and Game Service of that State). Research on fluctuations in mammalian populations has resulted in published papers on the meadow mouse and is being extended to other small mammals. An investigation of the fur resources of New York, their biology, economics, and conservation has been continued since 1926 and should be completed in a year or two.

A report not bearing directly on wildlife but of value in connection with the propagation of important wild-fowl food plants was issued in 1936 under the title, "Storage and Germination of Seeds of Aquatic Plants." Certainly Cornell is, and long has been, doing its full share of wildlife research.

Duke University (Durham, N. C.).--Biological effects of the denudation of forest floor both by removal and by burning of duff; food and parasites of rodents.

Idaho, University of (Moscow).--Research subjects include the limiting factors on the Hungarian partridge and ring-necked pheasant and the role of these birds in destroying or distributing weed seeds. Big-game studies being

carried on jointly with the Forest Service include winter censuses and experiments in improving the winter range of elk and deer; as well as observations on differential browsing by deer on plots variously fertilized.

Illinois, University of (Urbana).--Comparative censuses of birds in a variety of habitats; vertebrates of a strip-mine pond; biology and economic status of the crow; community relations of birds and mammals in an oak-maple forest; the mechanism of gonad stimulation by increasing period of light; fluctuations of lemming populations in the tundra; worm parasites of prairie chickens, wild ducks, and small mammals.

Louisiana State University (Baton Rouge).--Studies of the classification and distribution of the fauna of the State; populations of the cotton rat and rice rat; movements of chimney swifts by the banding method; and a quail investigation embracing extension of the findings of the Cooperative Quail Investigation of Georgia and Florida to Louisiana; limiting factors; artificial propagation; and physiological experimentation.

Massachusetts State College (Amherst).--A long-time investigation of the relation of forestry to wildlife. The purpose is to determine on a sample area the best combination of forestry procedures, including silviculture and timber utilization, for optimum production of both timber and wildlife. The primary motive is not to produce a maximum of either but the greatest total value of both. This means that both timber and wildlife production may be somewhat curtailed but that the total results will be more valuable and more satisfying, as judged by human needs, than the maximum production of either.

Michigan State College of Agriculture and Applied Science (East Lansing).--Banding of small birds has been carried on for years, the numbers totaling about 14,000; in the course of this work many weight and temperature records were taken and these are being summarized for publication. The W. K. Kellogg Bird Sanctuary, near Battle Creek, a field station of the College, has been the scene of recent research of the vertebrate ecology of this combined farm, forest, and bird refuge, with special emphasis on rabbits, skunks, and upland birds. The trematode parasites of waterfowl also have been studied there, and the migration, nesting, and food habits of waterfowl investigated.

Michigan, University of (Ann Arbor).--In the past this University has been very productive of wildlife research and at present a marvelous program of such investigation is in progress. Here as everywhere the importance of inventories is recognized, illustrative studies being an inventory of the wildlife resources of Washtenaw County; a method of evaluating a forest wildlife environment quantitatively; a quantitative study of the effects of wildlife management on song birds; a method of evaluating waterfowl environment; wildlife population studies, emphasizing the use of mathematics; population studies on fur-bearing animals; and experiments on methods of taking censuses of small mammals.

Other work on mammals includes a study of the life history of the fox squirrel; the normal and pathological histology of the white-tailed deer; livestock-poisoning plants in relation to deer; the carrying capacity of deer yards; the homes, home ranges, and individual wanderings, rate of multiplica-

tion, population densities, and metabolism of small mammals; and in addition, such general studies as the relation of geographic races and local varieties to environmental conditions, inherited variations in wild rodents, and fertility relations of races and species.

Bird investigations deal with factors controlling past and present distribution and abundance of the wild turkey and the ruffed grouse, the life history of the mourning dove, conservation of birds of prey,, and with the physiology of game birds, including a comparative study of the metabolism of different strains of wild turkeys in cooperation with the Pennsylvania Board of Game Commissioners.

Including work of its museum as an integral part of the University of Michigan's wildlife research program, there must be added among bird studies, life histories of the spotted sandpiper, cedarbird, Kirtland's warbler, and yellow-headed blackbird; a revision of flycatchers of the genus Empidonax; a bird population study on the Edwin S. George Reserve in Michigan; and general avifaunal investigations in Idaho, Wyoming, Michigan, and in the Davis Mountains, Texas.

Research on the diseases and parasites of wildlife, long prominent at the University of Michigan, is being carried on in great diversity. Sample subjects are the life histories of the giant kidney worm of mink and of lungworms in deer, fate of the large liver fluke in a herd of deer in a fenced enclosure, Leuchloridium parasites of marsh birds, and progressive loss of the protozoan parasite of ducks (Leucocytozoon) with recovery of the host.

Studies not easily classifiable in previous groupings relate to the overlapping of interests of wildlife and domestic animals, the effect of certain forestry practices on wildlife (in cooperation with the U. S. Forest Service on the Huron National Forest), the correlation of wildlife management and other land uses, recovery of Scotch pine following rabbit damage (a study now in its seventh year), and development of keys for identifying feathers, hair, and fur.

Montana State College (Bozeman).--Studies here, other than an investigation of the food of the ring-necked pheasant, concern animal diseases: Bang's disease in bison and elk; pneumonia in the Rocky Mountain bighorn sheep; and transmission of sheep scab and cattle scab to elk.

Montana State University (Missoula).--Distribution and habits of birds and mammals of the State; ecological relationships of important species and, cooperatively with the Forest Service, of factors involved in overpopulations of elk.

Nebraska, University of (Lincoln).--Field ecology of animals, including seasonal and stratal populations and their fluctuations in relation to climatic and biotic factors.

New Hampshire, University of (Durham).--Possibilities of increasing the bird population in woodland; food of deer; experimental wildlife management.

Pennsylvania State College (State College).--Silvicultural practices affecting deer foods as revealed by sample plots on a State forest and on "the barrens", an area frequently burned over. The major objectives at present are to obtain a list of the foods that deer prefer, and to learn their relative palatability.

Purdue University (Lafayette, Ind.).--Comparative studies of farm game environments; survival and growth of aquatic plants in waterfowl refuges; utilization of Lespedeza sericea as winter food for game.

Trinity College (Hartford, Conn.).--Research here relates mainly to sexual photoperiodicity of vertebrates and its modification by changed lighting.

Wisconsin, University of (Madison).--Life history investigations are being made of the Hungarian partridge and prairie chicken. A pheasant movement study, and researches to learn the relative values of feed-patch plants and of supplies for winter feeding stations have recently been reported upon. Among present studies are those of horned owl predation on game birds, a history of local wildlife as affected by ecological conditions and agricultural practices, and life history and management of beggarweeds--important wildlife food plants.

RESEARCH BY MUSEUMS

The activities of museums are largely expeditions to collect material, and taxonomic studies to work it up, but there are exceptions later noted.

American Museum of Natural History (New York, N. Y.).--This institution reports 1937 expeditions to Wyoming, the Grand Canyon, Rainbow Bridge and Monument Valley, Southeastern Alaska, the Nahanni Mountains, Yukon Territory, and central British Columbia, Canada.

California Academy of Sciences (San Francisco).--Banding of crown sparrows; distribution and ecology of birds of the Lake Tahoe, Tomales Bay, and other areas of the State; life histories and populations of wild geese; taxonomy of Canada geese; systematic and biologic studies of grouse of the genus Dendragapus; distribution and ecology of mammals of the Lake Tahoe region, life history and especially food habits of the coast black-tailed deer; systematics and natural history of the rabbits of California; censuses of mountain sheep; and statistical studies of game populations.

Charles R. Conner Museum (Pullman, Wash.).--Life histories of rodents and other small mammals.

Field Museum of Natural History (Chicago, Ill.).--This museum is engaged for the most part with exotic faunas, but always has given much attention to the biology of the Chicago area, where recently it has supported a study of the populations of breeding birds as a guide to song-bird management.

Museum of Vertebrate Zoology (Berkeley, Calif.).--The work of this museum has always had ecological bearings and much of it has departed from the field of ordinary museum activities. Work published upon within two years

awaiting publication, or now nearing the completed stage, may be summarized as follows:

Anatomical studies with dynamic bearing: Feather tracts of birds of prey; morphology of the pocket gopher (Thomomys); structural modifications in thrashers (Mimidae).

Systematic studies of variable groups: Brown bat (Eptesicus fuscus); mustelid mammals of the Americas; juncos; deer of the Pacific coastal region of North America; wood rats (Neotoma fuscipes); horned larks (Otocoris); pocket mice (Perognathus); pocket gophers (Thomomys); California rabbits and hares; moles (Scapanus) of California.

Natural history of species or groups: Microtus californicus; California quail; mule deer in California; wren-tit; California jay; magpies, California woodpecker.

Faunal treatments, of restricted or general natural history bearing: Vertebrates of Navajo Mountain, Utah; birds and mammals of Mount McKinley National Park; mammals of Death Valley; birds of Nevada; the fur-bearing mammals of California; the birds of California; the vertebrate animals of Point Lobos Reserve; vertebrates of Toyabe Mountains, Nev.; mammals of Idaho.

Natural History Museum (San Diego, Calif.).--Expeditions in Arizona, California, and Mexico; distributional, life-history, and taxonomic investigations.

New York State Museum (Albany).--Ecology of salt marshes to determine among other things the effect of mosquito-control ditching upon bird habitats; studies of bank and cliff swallows by the banding method; avifauna of Alleghany State Park; mammals of Rensselaer County.

United States National Museum (Washington, D. C.).--Continuation of the series of bulletins on life histories of North American birds and on classification of the birds of North and Middle America is an active project; local studies are made to fill gaps in knowledge of the distribution of birds and mammals of the eastern United States, recently worked States being West Virginia and Tennessee; a second edition of the list of North American recent mammals is being prepared; the effect of light on life is under investigation in connection with studies of sun phenomena that have bearing on climatic cycles.

RESEARCH BY MISCELLANEOUS ESTABLISHMENTS

Baldwin Bird Research Laboratory (Gates Mills, Ohio).--Although the work of this institution in the past has dealt largely with the house wren, it is now being extended to other passerine birds that are regarded as very sensitive in their reactions to environmental factors. Wren studies are being continued especially as to fluctuations in breeding and non-breeding, adult and immature populations, territoriality, sex ratio, matings, mortality, and response to environment. Cycles in abundance are indicated. Investigations planned to deal with a wide range of species include time, manner, and natural temperatures of incubation, periods on and off the eggs, quantity of

food and frequency of feeding of the young. With the cooperation of the Cleveland Bird Club and of the Biological Laboratory of Western Reserve University, attempts are being made to record and analyze the yearly variations in numbers of all local species. The ecology of birds in a beech-maple community has recently been published upon; a similar study relates to pine-hemlock forest; and another to the relation to birds of ecological succession in marsh and bog. Special studies made of the numbers and need for protection of hawks, owls, and the bobwhite in Ohio were fundamental to a campaign to assure better public policy toward these species.

Cooperative Quail Study Association (Thomasville, Ga.).--Food and cover plant investigations include correlation of agricultural and forestry practices with upland game management; the value of summer and winter cover crops to game; utility of controlled burning; value of volunteer vegetations; search for new and desirable game and wildlife feeds, especially early spring seeders; and experiments to determine the best fertilization of feed-patch plants for practical use. Predator studies include the life history of the fox, with special emphasis on diet during the breeding seasons of upland game; food habits of the opossum, skunk, and raccoon; life history of the cotton rat Population phenomena of this and other rodents also are a subject of investigation. Means of keeping deer out of areas where not desired have been studied, electrified fence having been found highly effective. Comparative studies of game-management practices in different localities and on different soils are constantly in progress.

Harvard Forest (Petersham, Mass.).--Present investigations include wildlife food production of various forest types in the Harvard Forest; the identity and value of woody plants used by wildlife in the Northeastern States biology of the red fox in Harvard Forest; and winter relations of the ruffed grouse to the forest in Petersham, Mass.

National Association of Audubon Societies (New York, N. Y.).--There are now two research fellowships supported by the Association for the benefit of species the existence of which appears to be threatened; one established at Cornell University has as its object the ivory-billed woodpecker, and the other at the University of Arizona the desert bighorn. A study of the herring gull by the aid of colored bands is being carried on cooperatively by this Association, the Linnaean Society of New York, the Northeastern Bird Banding Association, the Bureau of Biological Survey, and the National Parks Bureau of Canada.

Roosevelt Wildlife Forest Experiment Station (Syracuse, N. Y.).--Recently published: "Reconnaissance of the Land Vertebrates of the Huntington Wildlife Forest Station"; "Effect of Deer Browsing on Certain Western Adirondack Forest Types." Awaiting publication are reports on the ecology of birds of the northern boundary of New York State, and on birds of the Catskill Mountains. A continuing project covers ecological and population studies of small mammals, a progress report upon which was published in 1935. Plans provide for intensive investigation on the Huntington Forest of the distribution, populations, ranges, food and cover preferences, and seasonal activities of forest wildlife and its response to forest and wildlife management, in exploration of the feasibility of forest management that takes into account all forest products.

CANADIAN WILDLIFE RESEARCH

So far as known most of the wildlife research in Canada is official. The Biological Board engaged chiefly in fisheries research has cooperated with the National Parks Bureau in studying the economic importance of fish-eating birds. The status of the American merganser in British Columbia has recently been reported upon and that of the goldeneye ducks is being investigated. The National Parks Bureau has produced recently published reports also on a waterfowl reconnaissance of Wood Buffalo Park, Northwest Territories, and on the migrations of the American brant. Presently active projects include investigations of population cycles of the varying hare (this in cooperation with the Bureau of Animal Populations, Oxford, England); experimental transplanting of eelgrass from the Pacific to the Atlantic Coast of Canada; determination of the reproductive rate of the American eider on the north shore of the Gulf of St. Lawrence; and collaboration in the Linnaean Society of New York's cooperative field study of the herring gull by means of colored bands.

The National Museum of Canada, to which we are indebted for useful books on the birds of that country, is continuing ornithological surveys by the method of traverses that will develop the zonal distribution of birds. A line that has been worked recently runs from Churchill on Hudson Bay to the southern boundary of Manitoba. The most active taxonomic study is that of great horned owls.

Field expeditions of the Museum, in search of bird, mammal, and other material, in the last three years explored the coast of British Columbia, Thelon Game Sanctuary, and the eastern Arctic, and parts of Manitoba, Ontario, Quebec, and Nova Scotia. A report on the mammals and birds of the western Arctic District Northwest Territories, has recently been published, and a report on the life zones and a check-list of the mammals of Canada are planned

The Royal Ontario Museum of Zoology in conjunction with the University of Toronto has published on studies of population fluctuations of the ruffed grouse, and on incursions of the sharp-tailed grouse and ptarmigan, and a study on the periodic fluctuations of the varying hare is ready for printing. Changes in the wolf and coyote populations of Ontario and their relation to the number of deer also have been treated in recent publications. The Museum is especially interested in cyclic phenomena and sends out an annual questionnaire to trappers, sportsmen, and naturalists in an effort to keep as accurate a record as possible of the changes in number of a wide variety of mammals, birds, and other animals. With the support of a private donor the Museum is conducting a survey of conditions affecting wildlife in King Township, as a guide to a demonstration project in wildlife management.

COST OF WILDLIFE RESEARCH

No estimate can be given of the present total cost of wildlife research but illuminating sample budgets are available.

One of the units in the series for Federal-State Cooperative Research in Wildlife Management, namely, Iowa State College, reports a total wildlife budget for this year of $30,620, of which $22,820 is specifically allotted to research.

Amounts allocated by the Bureau of Biological Survey for research in the present fiscal year total $439,857, distributed as follows:

Salaries and Expenses, Bureau of Biological Survey:	
Food Habits of Birds and Animals	$68,140
Fur Resources Investigations	1/ 66,000
Biological Investigations	1/ 2/171,149
Control of Predatory Animals and Injurious Rodents	35,500
Protection of Migratory Birds	51,000
Migratory Bird Conservation Refuges	1/ 20,868
Migratory Bird Conservation Fund	15,000
Bankhead-Jones Research Fund	12,200
	$439,857

Nearly half a million dollars thus is accounted for by the budgets of one Federal bureau and one State college; it must be surmised that the total figure runs into several millions.

NUMBER OF PROJECTS

A basic difficulty in the preparation of this report is one that is confronted in almost every direction--that of deciding where to draw lines. What research activities are important enough to take into consideration? Which should be classed as distinct projects? Is a piece of cooperative research to be reckoned as a single undertaking or given multiple standing corresponding to the number of cooperators? These and other queries have required answers in each case as raw material was being incorporated into the report, and on those individual decisions depends the validity of any numerical summaries that may be made. In any event accuracy is not claimed; suggestion value is about all that can be expected.

For the Biological Survey, 54 research projects are recorded and 43 additional for the Survey in collaboration with seven other Federal agencies. The Cooperative Research in Wildlife Management involving nine States is credited with 47 projects, and cooperation with six other States with 15. The total for the Biological Survey and cooperators is 159.

Six Federal organizations are engaged in 35 research undertakings in addition to those included in Survey cooperation, three of the offices, with 20 projects, being credited to the Department of Agriculture, and three, with 15 projects, to other Departments.

Research problems undertaken by 18 State conservation departments, including supplementary studies by three States in the Federal-State cooperative chain, number 90. Those for 19 colleges and universities total 144; for eight museums, 66; for five miscellaneous establishments, 34; and for five Canadian institutions, 28.

1/ Allotments for disease investigations are made from these appropriations in the following amounts, respectively, $16,270; $1,750; and $14,900.

2/ Of this amount, $30,000 was appropriated for the cooperative research stations. Ten or more stations will be in operation during 1938.

The total is some 550; the average of independent projects of Federal bureaus other than the Biological Survey, for States whether in the cooperative agreement or not, and for Canadian institutions, is about 5; for the colleges, universities, and miscellaneous establishments, about 7; and for the museums, about 8, each.

NUMBER AND SYNOPSIS OF SUBJECTS

The figures given in the synopsis at the end of this section do not agree with those of the previous sections because some research projects deal with more than one subject. For example, life history studies often put so much emphasis upon food habits that there is a question as to the main trend--a doubt often resolved by crediting them to both branches of research. Duplicate classification occurs also in other cases, but reduction from the project basis also affects this analysis of objectives, as when two or more institutions in the same State are investigating the same subject. State and other regional designations in the following outline usually indicate the site of the research, but often also they refer to the headquarters from which it is being conducted.

Biological Surveys and Distributional Studies

Avifauna of--
- Alleghany State Park (N.Y.)
- California (Calif.)
- Chicago region (Ill.)
- Idaho (Mich.)
- Lake Tahoe region (Calif.)
- Michigan (Mich.)
- Nevada (Calif.)
- New York (N.Y.)
- Oklahoma (N.Y.)
- Tennessee (D. C.)
- Texas (Mich., N. Y.)
- Tomales Bay (Calif.)
- West Virginia (D. C.)
- Wyoming (Mich.)

Banding of--
- Birds in general (D. C.)
- Chimney swift (La.)
- Crown sparrows (Calif.)
- Herring gull (D. C., Mass., N. Y., Canada)
- Miscellaneous birds and mammals (Pa.)
- Planted game birds (Pa., Wis.)
- Ruffed grouse (Wis.)
- Small birds (Mich.)
- Swallows (N. Y.)

Biological expeditions--
- Alaska (D. C., N. Y.)
- Arizona (Calif., N. Y.)
- British Columbia (N. Y.)

Biological expeditions--Continued.
- California (Calif.)
- Eastern Arctic (Canada)
- Manitoba (Canada)
- Mexico (Calif.)
- Nova Scotia (Canada)
- Ontario (Canada)
- Quebec (Canada)
- Thelon Game Sanctuary (Canada)
- Utah (N. Y.)

Birds and mammals of--
- Louisiana (La.)
- Montana (Mont.)
- Mount McKinley National Park (Calif.)
- Western Arctic District, N. W. T. (Canada)

Bird-refuge populations (Vt.)

Bird rookeries of Great Salt Lake (Utah)

Fur animals (Calif., Ill.)

Fur and game species (Minn.)

Fur resources (N. Y.)

Incursion of--
- Ptarmigan (Canada)
- Sharp-tailed grouse (Canada)

Life zones--
- Arizona (D. C.)
- Canada (Canada)
- Florida (D. C.)
- Georgia (D. C.)
- Oregon (D. C.)
- Wisconsin (D. C.)

Mammals of--
- Arizona (D. C.)
- Canada (Canada)
- Death Valley (Calif.)
- Florida (D. C.)
- Georgia (D. C.)
- Idaho (Calif.)
- Lake Tahoe region (Calif.)
- Oregon (D. C.)
- Rensselaer County (N. Y.)
- Tennessee (D. C.)
- West Virginia (D. C.)
- Wisconsin (D. C.)

Migration--
- American brant (Canada)
- General (D. C.)
- Waterfowl (D. C., Mich.)

Vertebrates of--
- British Columbia coast (Canada)
- Huntington Wildlife Forest Station (N. Y.)
- Navajo Mountain (Calif.)
- Point Lobos Reserve (Calif.)
- Toyabe Mountains, Nevada (Calif.)

Waterfowl, general (D. C.)

Waterfowl of Wood Buffalo Park, N. W. T. (Canada)

Wildlife of economic importance (Miss.)

Wildlife resources (Mich., Ohio, Tex.)

Zonal distribution of birds (Canada)

Control

Coyote (Colo.)

Deer repellents (Ga.)

Meadow mice (Colo.)

Muskrat (Calif.)

Pheasant repellents (Minn.)

Pocket gophers (Colo.)

Selective poisons (Colo.)

Diseases and Parasites

Bang's disease in bison and elk (Mont.)

Birds--
- Bobwhite (Ill.)
- Ducks (Ill., Mich.)
- Grouse (D. C.)
- Hungarian partridge (Ohio)
- Marsh birds (Mich.)
- Pheasant (Ill., Ohio)
- Prairie chicken (Ill., Nebr.)
- Quail (D. C.)
- Ruffed grouse (Minn.)
- Sharp-tailed grouse (Nebr.)
- Waterfowl (Ill.)

Botulism (D. C., Nebr.)

Fish-eating birds as carriers of fish parasites (Maine)

Fluctuations in wildlife populations as affected by diseases and parasites (Mich., Minn.)

General (D. C., Iowa)

Kidney worm in minks (Mich.)

Leuchloridium in marsh birds (Mich.)

Leucocytozoon in ducks (Mich.)

Liver fluke in deer (Mich.)

Lung worm in deer (Mich.)

Mammals--
- Bighorn (Mont.)
- Deer (Mich., Minn.)
- Elk (Utah)
- Fur animals (Ill.)
- Mink (Mich.)
- Moose (Minn.)
- Rodents (N. C.)
- Small mammals (Ill.)
- Snowshoe hare (Minn.)

Parasites common to wildlife and domestic animals (D. C., Mich.)

Pathological histology of white-tailed deer (Mich.)

Plague in rodents, Western States (Calif., D. C.)

Pneumonia in bighorn sheep (Mont.)

Scabies, transmission to elk (Mont.)

Tick fever in deer, Florida (D. C.)

Trematodes of waterfowl (Mich.)

Tularemia in birds and rodents (D. C.)

Typhus in rodents, Southeastern States (D. C.)

Wildlife as reservoirs of diseases affecting man (Calif., D. C.)

Wildlife in general (Minn., N. Y.)

Ecological Problems

Artificial lakes, utility to wildlife (Tenn., Va.)

Beavers in relation to stream flow and fishes (Utah, W. Va.)

Birds of--
- Beech-maple forest (Ohio)
- Pine-hemlock forest (Ohio)

Carrying capacity of deer yards (Mich.)

Census methods (Maine, Mich., Pa., Utah)

Community relations--
- In oak-maple forest (Ill.)
- Of the W. K. Kellogg Bird Sanctuary (Mich.)

Comparative censuses of birds in different habitats (Ill.)

Comparative studies of farm game environments (Ind.)

Conditions affecting wildlife in King Township, Ontario (Canada)

Correlation of cover types and wildlife distribution (Conn.)

Coyote in natural environment (Calif.)

Cycles in wildlife as related to those in climate (D. C.)

Denudation of forest floor in relation to wildlife (N. C.)

Ecology of birds of northern New York (N. Y.)

Estimating age of deer (Calif.)

Evaluation of--
- Forest environment (Mich.)
- Waterfowl environment (Mich.)

Fertility relations of races and species (Mich.)

Fluctuations in--
- Animal populations (Mich., Minn., Nebr.)
- Lemming (Ill.)
- Ruffed grouse (Minn. Canada)
- Varying hare (Minn. Canada)

Food production of forest types (Mass.)

Forest regeneration as affected by wildlife (Calif., Mass.)

Local races in relation to environmental conditions (Mich.)

Mosquito-control operations in relation to wildlife (D. C., N. Y., Tenn.)

Numbers of waterfowl (D. C.)

Overpopulation of elk, factors involved (Mont.)

Pheasant movements (Wis.)

Photoperiodism (Conn., Ill.)

Physiology of game species in relation to climatic conditions (Mich., Pa.)

Plants of waterfowl breeding grounds (Iowa, Utah)

Population studies--
- Aided by mathematics (Mich.)
- Bird and insect populations, correlation of (Ill.)
- Birds in general (Mich., Ohio)
- Cotton rat (Ga., La.)
- Deer (Idaho, Mich., Minn.)
- Elk (Idaho)
- Fur animals (Mich.)

Population studies--Continued.
- Geese (Calif.)
- House wren (Ohio)
- Rice rat (La.)
- Small mammals (Ga., Mich., N. Y.)
- Statistical (Calif.)

Range productivity as affected by wildlife (Calif.)

Range study of--
- Bighorn (Ariz., Colo., Wyo.)
- Elk (Ariz., Colo., Wyo.)

Rodent competition with valley quail (Calif.)

Song birds, effects of management on (Mich.)

Status of threatened species (Ariz., N. Y., Ohio)

Succession in bogs and marshes as affecting birds (Ohio)

Summer range of deer (Calif., Utah)

Winter range of deer (Calif., N. H., Pa., Utah, Wash.)

Winter relations of ruffed grouse to the forest (Mass.)

Food Habits

Birds--
- Almond-eating birds (Calif.)
- American merganser (Mich. B.C.)
- Bobwhite (Ala., Del., Ill., Md., Ohio, S. C.)
- Coot (D. C.)
- Crow (Ill.)
- Fish-eating birds (D. C., B. C.)
- Game birds in relation to weed seeds (Idaho)
- Goldeneye ducks (B. C.)
- Hawks (Pa.)
- Hungarian partridge (D. C., Ohio)
- Mourning dove (D. C.)
- Orioles destroying fruit in New York (D. C.)

Birds -- Continued
- Owls (Pa.)
- Pheasant (Ill., Minn., Mont., Ohio. Utah)
- Raptorial birds (D. C.)
- Ruffed grouse (N. Y., Va.)
- Scaled quail (D. C.)
- Waterfowl (Mich.)
- White-necked raven (Colo.)
- Wild turkey (Ky., Va.)

Mammals--
- Armadillo (Colo.)
- Black bear (Va.)
- Bobcat (D. C., Vt.)
- Coast black-tailed deer (Calif.)

Mammals--Continued.
- Cottontail (Md.)
- Coyote (Calif., Colo.)
- Deer (Mont., Vt.)
- Deer browsing in relation to--
  - Differential fertilization (Idaho)
  - Forest types (N. Y.)
- Elk (Mont.)
- Fox (Ala., Ga., N. Y., Va.)
- Mule deer, palatability ratings of food (Ariz., Calif.)
- Opossum (Ga.)
- Otter (Mich.)
- Predators (Mich.)
- Rabbits, in relation to forest planting (Minn.)

Mammals--Continued.
- Rabbit damage to Scotch pine (Mich.)
- Raccoon (Ga.)
- Red fox (D. C.)
- Rodents (N. C.)
- Rodents in relation to forest planting (Minn.)
- Skunk (Ga., Iowa)
- White-tailed deer (Minn., Mo., N. H., N. C.)

White-tailed deer--
- Palatability ratings of food (Ariz., N. Y., Pa.)
- Nutritional requirements (N. Y.)

Life Histories

Birds--
- Arctic tern (Maine)
- Atlantic puffin (Maine)
- Black guillemot (Maine)
- Black-backed gull (Maine)
- Blue jay (N. Y.)
- Blue-winged teal (Iowa)
- Bobwhite (Ala., Del., Ill., Iowa, La., Md., Okla., S. C., Tex.)
- California jay (Calif.)
- California quail (Calif.)
- California woodpecker (Calif.)
- Canvasback, mating cycle (N. Y.)
- Cedarbird (Mich.)
- Crow (Ill.)
- Double-crested cormorant (N. Y.)
- Eider duck (Maine)
- Eider duck, reproductive rate (Canada)
- English sparrow (N. Y.)
- Herring gull (Maine)
- Geese (Calif.)
- Grouse of the genus Dendragapus (Calif.)
- Horned lark (N. Y.)
- Horned owl (N. Y.)
- House wren (Ohio)
- Hungarian partridge (Wis.)
- Ivory-billed woodpecker (N. Y.)
- Kirtland's warbler (Mich.)
- Lesser prairie chicken (Okla.)
- Magpies (Calif.)
- Mourning dove (Ala., Iowa, Mich.)
- Pheasant (Ill., Iowa, Wis.)

Birds--Continued.
- Phoebe (N. Y.)
- Prairie chicken (Ill., Lake States, Tex., Wis.)
- Redstart (N. Y.)
- Robin (N. Y.)
- Ruffed grouse (Maine, N. Y., Ohio, Pa., W. Va.)
- Ruffed grouse, mating cycle (Maine, N. Y.)
- Sage grouse (Utah)
- Sandhill crane (Lake States)
- Screech owl (N. Y.)
- Sharp-tailed grouse (Lake States, Utah)
- Small birds, temperatures and weights (Mich.)
- Songs of birds (N. Y.)
- Spotted sandpiper (Mich.)
- Tree sparrow (N. Y.)
- Turkey buzzard (N. Y.)
- Upland game birds (Mich.)
- Valley quail (Calif.)
- Waterfowl--
  - Migration (D. C., Mich.)
  - Nesting (Mich.)
  - Ranges (D. C., Mich.)
- Wild ducks, sex ratio (Utah)
- Wild turkey (Ky., Mo., Pa.)
- Woodcock (Maine, N. Y.)
- Wren-tit (Calif.)
- Yellow-headed blackbird (Mich.)

Mammals--
- Antelope (Oreg.)
- Beaver (Mich.)
- Caribou (Lake States)
- Coast black-tailed deer (Calif.)
- Cotton rat (Ga.)
- Cottontail (Conn., Iowa., Mich., Ohio)
- Coyote (Colo.)
- Elk (Utah)
- Fur animals of California (Calif.)
- Gray fox (Ga., Minn.)
- Ground hog (Ohio)
- Meadow mice (Calif.)
- Moose (Lake States)
- Mule deer (Ariz., Calif., Utah)

Mammals--Continued
- Muskrat (Calif., Iowa, Md.)
- Muskrat, sex ratio (Utah)
- Rabbits (Calif.)
- Raccoon Iowa, Maine)
- Red fox (Mass.)
- Rodents, inheritance studies (Mich.)
- Skunks (Iowa, Mich.)
- Small mammals (Mich., Wash.)
- Squirrels (Mich., Ohio, Tex., W. Va.)
- Varying hare (Lake States)
- White-tailed deer (Ariz., Maine, N. Y., Ohio, Pa., W. Va.)
- White-tailed deer, birth rate sex ratio (Oreg.)

Limiting Factors

Affecting--
- Bobwhite (La., Va.)
- Hungarian partridge (Idaho)
- Pheasant (Idaho)
- Raccoon (Maine)
- Ruffed grouse (Mich.)
- Small game (Oreg.)
- Valley quail (Calif.)
- White-tailed deer (Ariz., N. Y.)
- Wild turkey (Mich.)

Causes of winter and spring losses of moose (Maine)

Crippling losses (Utah)

Depletion of eelgrass, Atlantic coast of the United States and Canada (D. C., Canada)

Grazing in relation to--
- Upland game (Calif., Okla., Utah)
- Waterfowl (Utah)

Hunting, on--
- Bobwhite (Ill.)
- Deer (N. Y., Vt.)
- Game species (N. J.)
- Wild turkey (Ala.)

Inbreeding in bobwhite (Nebr.)

Insecticides in relation to--
- Birds (D. C.)
- Wildlife (D. C.)

Lead poisoning of waterfowl (D. C.)

Mosquito-control operations (D. C., N. Y., Tenn.)

Stock-poisoning plants in relation to deer (Mich.)

Management

Agriculture in relation to wildlife management (Ga., Wis.)

Aquatic plants, survival on refuges (Ind.)

Beggarweeds, life history and value of (Wis.)

Birds--
- Blue-winged-teal (Iowa)
- Bobwhite (Ala., Iowa, Md.)

Birds--Continued.
- Mourning dove (Iowa)
- Pheasant (Iowa, Vt.)
- Prairie chicken (Mich.)
- Ruffed grouse (Mich., N. H., Vt., Va.)
- Sharp-tailed grouse (Mich.)
- Songbird (Ill., N. H.)
- Waterfowl (Mich.)
- Wild turkey (Ala., Mo., Va.)
- Wood cock (Maine)

Comparative studies of game management practices (Ga.)

Controlled burning (Ga.)

Controlled hunting (Mich., N.J., Ohio)

Correlation of wildlife management and other land uses (Ga., Mass., Mich., N. Y.)

Cover crops in relation to game (Ga.)

Development of--
- Non-toxic shot (Minn.)
- Mosquito larvicide harmless to wildlife (D. C.)

Estimating game populations (Conn.)

Experimental wildlife management (N.H.)

Farm game (N. Y.)

Farmer-sportsman relationship (Iowa, Mich.)

Feed-patch plants, relative values of (Ill., Wis.)

Feed-patch seed mixtures (Conn., Md., N. J.)

Fertilization of feed patches (Ga.)

Forest management in relation to wildlife management (Ala., Ga., Maine, Mass., Mich., N. H., N. Y., Pa.)

Fruits attractive to birds (D. C.)

Herd regulation, moose (Mich.)

Inventory of--
- Deer population (Mich)
- Fur production (Vt.)
- Mountain sheep (Calif.)

Lespedeza, value of (Ind., N. J.)

Lumbering in relation to--
- Deer (Ala., Maine)
- Ruffed grouse (Maine)
- Wildlife (Mass.)

Mammals--
- Antelope (Oreg.)
- Beaver (Minn., Pa.)
- Cottontail (Conn., Iowa, Md.)
- Fur animals (Minn.)
- Moose (Mich.)
- Mule deer (Utah)
- Muskrat (Iowa, Md.)
- Olympic elk (Wash.)
- Raccoon (Iowa)
- Skunk (Iowa)
- White-tailed deer (Mich., Mo., Vt., Va.)

Minimum of improvement desirable (Ind.)

Plantings, value to wildlife (Md., Tenn.)

Plants valuable for wildlife utilization (D. C.)

Propagation, artificial--
- Black duck (N. Y.)
- Bobwhite (La., N. Y.)
- Pheasant (N. Y.)
- Ruffed grouse (N. Y.)

Propagation of food-producing trees and shrubs (Md.)

Propagation, transplanting, and control of aquatic vegetation (D. C.)

Protection of plants valuable to wildlife from insect pests (D. C.)

Range improvement, deer and elk (Idaho)

Refuge areas, effect on game populations (W. Va.)

Refuges for sage grouse (Wyo.)

Revegetation of logged and burned areas in the Southeastern States (D. C.)

Silviculture in relation to--
- Deer (Maine, N. Y., Pa.)
- Ruffed grouse (Maine, N. H., N. Y.)
- Wildlife (Mass., Mich.)

Spring seed bearers (Ga.)

Stocking--
- Bobwhite (N. Y.)
- Chukar partridge (Mo.)
- Mallard (N. Y.)
- Pheasant (N. Y.)
- Various extralimital species (Wis.)

Storage and germination of seeds of aquatic plants (N. Y.)

Transplanting eelgrass, Pacific to Atlantic coast (D. C., Canada)

Volunteer vegetation, value for wildlife (Ga.)

Wildlife as a supplementary farm enterprise (D. C.)

Winterfeeding, relative value of grains for (Wis.).

Woody plants, their value to wildlife (Mass.)

Predation

Armadillo-quail relationship (Tex.)

Crow-waterfowl relationship (N. Dak., Alberta, Sask.)

Fire-ants versus bobwhites (D. C., Ga.)

Horned owl on game birds (Wis.)

Population problems (Mich.)

Taxonomic and Related Studies

Birds--
- Birds of Middle America (D. C.)
- Birds of North America (D. C.)
- Birds of prey, feather tracts of (Calif.)
- Blue jay (N. Y.)
- Canada goose (Calif.)
- Clapper rail (D. C.)
- Finches and sparrows, juvenal plumage (N. Y.)
- Flycatchers of the genus Empidonax (Mich.)
- Grouse of the genus Dendragapus (Calif.)
- Horned lark (Calif.)
- Red-tailed hawk (N. Y.)
- Thrashers, structure of (Calif.)

Development of keys for identifying feathers (Mich.)

Mammals--
- Brown bat (Calif.)
- Deer of the Pacific coast (Calif.)
- Mammals of Canada (Canada)
- Mammals of North America (D. C.)
- Moles (Calif.)
- Pocket gopher (Calif.)
- Pocket mice (Calif.)
- Puma (D. C.)
- Rabbits (Calif.)
- Spermophiles (D. C.)
- Tree squirrels (D. C.)
- Wolves (D. C.)
- Wood rats (Calif.)

Development of keys for identifying hair and fur (D. C., Mich.)

Other--
- Check-list of marsh and aquatic plants (D. C.)
- Preparation of a manual for identification of seeds (D. C.)

Number of Subjects

Totaling the numbers of researches distributed in the preceding synopsis there are on--

Biological Surveys and distributional studies	88
Control	7
Diseases and parasites	52
Ecological problems	88
Food habits	72
Life histories	136
Limiting factors	32
Management	121
Predation	8
Taxonomic and related studies	30

Some of these groups may be further commented upon to advantage. The 79 ecological investigations embrace 56 subjects, of which the most popular are range studies of deer, 7 in number; of other big-game ruminants, bighorn and elk together, 6; and comparative studies of census methods, 4.

It is of interest that despite earlier emphasis on studies of the food habits of birds, there are now more dietary investigations of mammals, 38 as compared with 34. The favorite species in the bird group is the bobwhite, with 6 studies under way; and among the mammals, foxes and the white-tailed deer, with 4 each.

Life-history researches are divided, 45 for mammals and 81 for birds. The mammalian studies relate to 24, mostly specific groups, of which 11 are game, 8 fur, and 5 of other classification. The white-tailed deer is well in the lead as an objective, with 7 investigations in as many States. The bird life histories concern 22, mostly specific groups of game, and 28 similar groups of nongame birds. It is a satisfaction that wildlife research is preserving its breadth of scope and has not become merely an adjunct to game management. The favored species among the game birds is the bobwhite with 9 studies in progress; the nongame projects are distributed, almost entirely, one to a species.

Among limiting factors other than disease and predators, grazing in relation to game birds with 4 studies, and mosquito-control operations as affecting wildlife with 3, are in the lead.

The researches on management items, totaling 121, relate to 78 subjects, of which 11 are studies of the management of definite groups of birds and an equal number of mammals. The ruffed grouse is the favored bird species with 4 projects devoted to it, and the white-tailed deer the most frequently selected mammal, with the same number. The subject from the entire list of management researches that is receiving most attention is forestry in relation to wildlife management, with 8 going projects.

CONCLUSION

In conclusion it is evident that there is greater appreciation of the value of wildlife research than ever before and that there is more of it being done than in any previous period. Granted reasonable prosperity in the Nation, these trends will doubtless continue.